A Plasma Aerocapture and Entry System for Manned Missions and Planetary Deep Space Orbiters

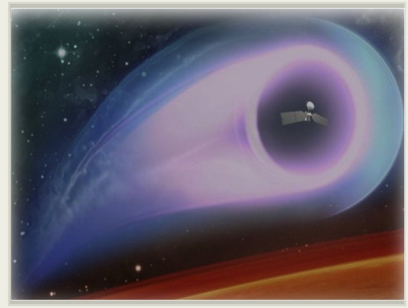
Completed Technology Project (2012 - 2013)

Project Introduction

The Plasma Magnetoshell works like a ballute, where plasma takes the place of inflated fabric. The primary drag-inducing interaction between the magnetically confined plasma ions and the incoming neutral atmospheric particles is that of charge exchange. The Plasma Magnetoshell is based on demonstrated experimental results and the successful implementation would dramatically decrease mission risk, launch cost, mass, and overall radiation exposure. The Plasma Magnetoshell is a high-Beta (the ratio of plasma to magnetic field energy density) dipole plasma configuration which would initially be populated with ambient atmospheric gases. This plasma is formed, sustained, and expanded with an electrodeless Rotating Magnetic Field (RMF), which has been shown in previous experiments to generate the required, fully ionized, high temperature magnetized plasma. RMF plasma formation induces large currents in the plasma that inflate and maintain the large-scale magnetic structure. The primary drag-inducing interaction between the magnetically confined plasma ions and the incoming neutral atmospheric particles is that of charge exchange, which has the largest cross section. After a charge exchange, the now magnetized atmospheric ion reacts its directional momentum (in the frame of the spacecraft) onto the magnet via field line bending and stretching.

Anticipated Benefits

A plasma Magnetoshell can enable a wealth of large scale inner planetary missions and deep space planetary orbiters. Aerocapture and aerobraking use aerodynamic drag in a planetary atmosphere in order to decelerate and shed velocity from a planetary transfer orbit. Aerobraking systems have been shown to dramatically reduce the mass and cost of interplanetary orbiters.



Project Image A Plasma Aerocapture and Entry System for Manned Missions and Planetary Deep Space Orbiters

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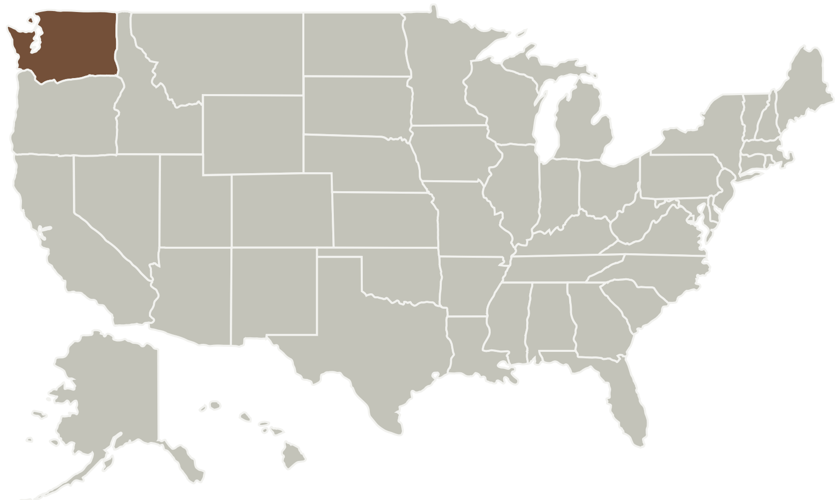
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
MSNW, LLC	Lead Organization	Industry	Redmond, Washington

Primary U.S. Work Locations
Washington

Project Transitions

September 2012: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

MSNW, LLC

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

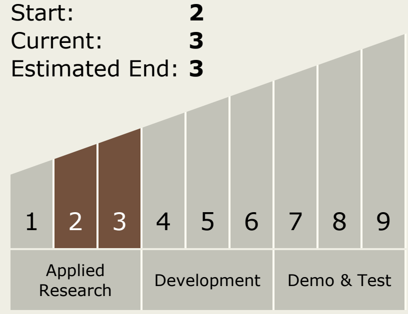
Eric A Eberly

Principal Investigator:

David Kirtley

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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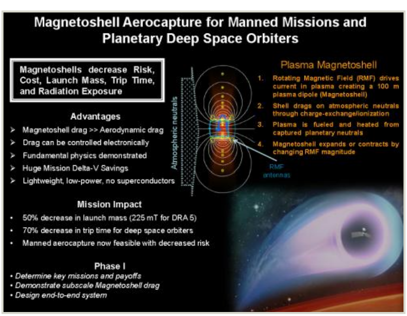
June 2013: Closed out

Closeout Summary: A plasma Magnetoshell can enable a wealth of large scale inner planetary missions and deep space planetary orbiters. Aerocapture and ae robraking use aerodynamic drag in a planetary atmosphere in order to decelerat e and shed velocity from a planetary transfer orbit. Aerobraking systems have b een shown to dramatically reduce the mass and cost of interplanetary orbiters. Aerocapture systems use a high temperature ceramic Aeroshell and thermal pro tection system (TPS) to extend those benefits to allow not only orbit lowering, b ut injection orbit capture as well. Mission studies have shown the Aerocapture is a dramatically enabling technology for interplanetary science and manned missi ons and critical for the future of NASA space travel. The Magnetoshell aerocaptu re deploys a magnetic field filled with a magnetized plasma. It is interaction of t he atmosphere with this plasma that supplies a significant impediment to atmos pheric flow past the spacecraft, and thereby producing the desired drag for braki ng. The plasma based Magnetoshell being developed in this program holds the p otential to perform the desired braking with significantly increased drag and con trol while reducing mass. Most importantly, as the drag can be varied dynamicall y this technology significantly lowers the risk involved with aerocapture thereby making interplanetary aerocapture possible without detailed a prior knowledge o f a planet's atmosphere. In Phase I a full system was designed for Neptune and Mars missions. This analysis showed that a 200 kg, 9 m Magnetoshell provides Neptune aerocapture for a 21 km/s injection with a peak force of 150 N. For a m anned Martian aerocapture, a 21 meter Magnetoshell can be developed to provid e aerocapture for a 60 metric ton payload. A transient analytic model was devel oped evolving the radial plasma parameters for a variety of plasma, neutral, and magnetic parameters. Finally, a stationary 2 meter argon Magnetoshell was fully demonstrated and a 1000:1 increase in aerodynamic drag was found.

Images



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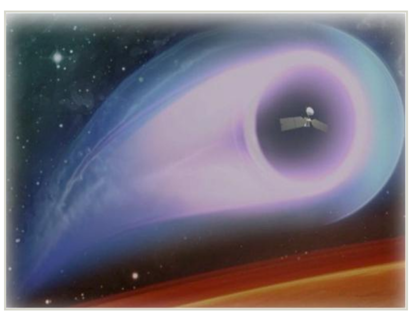
Project Image A Plasma Aerocapture and Entry System for Manned Missions and Planetary Deep Space Orbiters *(https://techport.nasa.gov/image/102304)*



11555-1366736632230.jpg
Project Image A Plasma Aerocapture and Entry System for Manned Missions and Planetary Deep Space Orbiters *(https://techport.nasa.gov/image/102091)*

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.3 In-Situ Instruments and Sensors
    └ TX08.3.1 Field and Particle Detectors

Target Destinations

Earth, The Moon, Mars